

REPORT DOCUMENTATION PAGE

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MEMORANDUM FOR PRS (In-House Publication)

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PR 100-05

16 April 2002

SUBJECT: Authorization for Release of Technical Information, Control Number: **AFRL-PR-ED-VG-2002-083**
Patrick Ruth et al. (PRSM), "Effects on Processing by Drop-in Modifiers in Nano-Composite Polymers"

SAMPE Industry Conference
(Long Beach, CA, 12-15 May 2002) (Deadline: 12 May 2002)

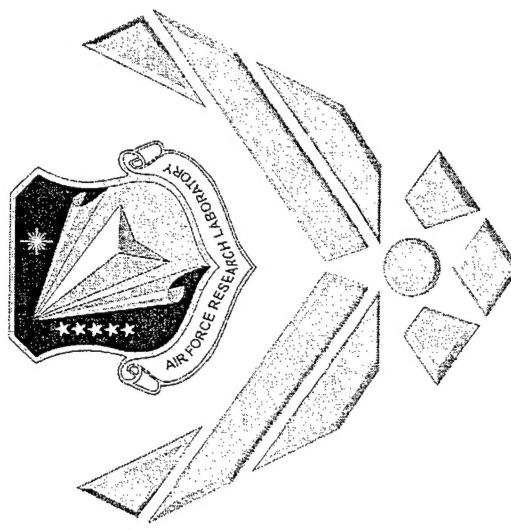
(Statement A)

*“Effects on Processing by Drop-in Modifiers
in Nano-Composite Polymers”*

Patrick Ruth,

Senior Technician, AFRL/PRSM
Air Force Research Lab, Edwards

Brent Viers, Rusty Blanski, and Andre Lee



DISTRIBUTION STATEMENT A
Approved for Public Release
Distribution Unlimited

POSS as a Drop-in Modifier- Introduction

What is POSS? (Simplified)

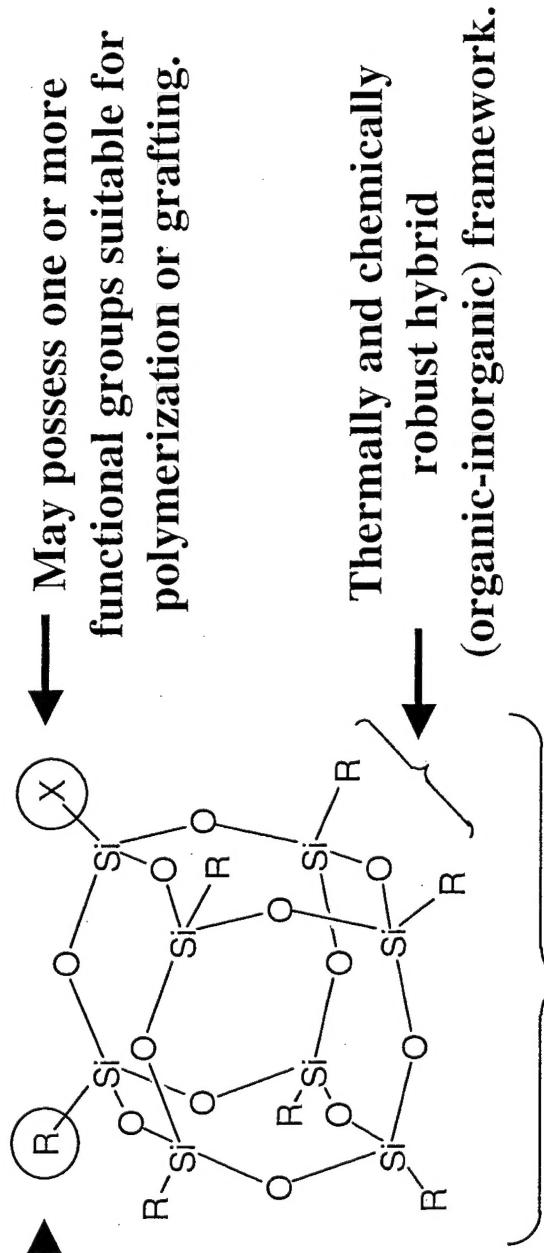
1. Structure
2. Functional Groups and Dropping-in
3. Proposed and Actual uses

Making Samples

1. Material Selection and Preparation
2. Blending
3. Sample Production

Anatomy of a Polyhedral Oligomeric Silsesquioxane (POSS™) Molecule

Nonreactive organic (R) groups for solubilization and compatibilization.

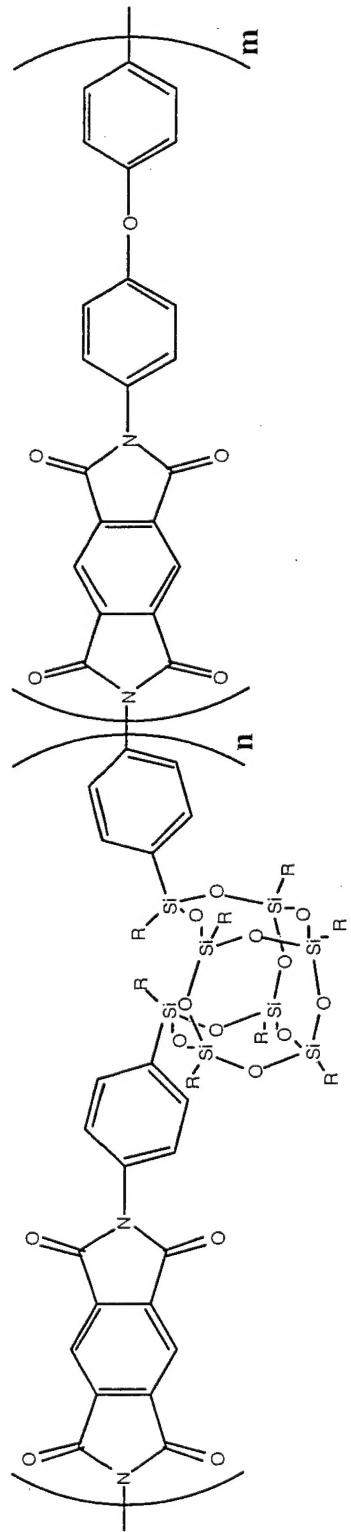


Nanoscopic in size with an Si-Si distance of 0.5 nm and a R-R distance of 1.5 nm.

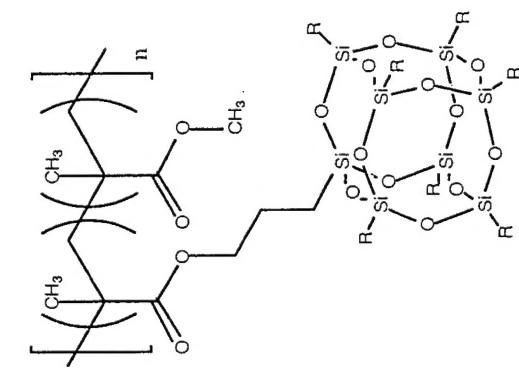
- thermally and chemically robust hybrid (organic-inorganic) framework.

Precise three-dimensional structure for molecular level reinforcement of polymer segments and coils.

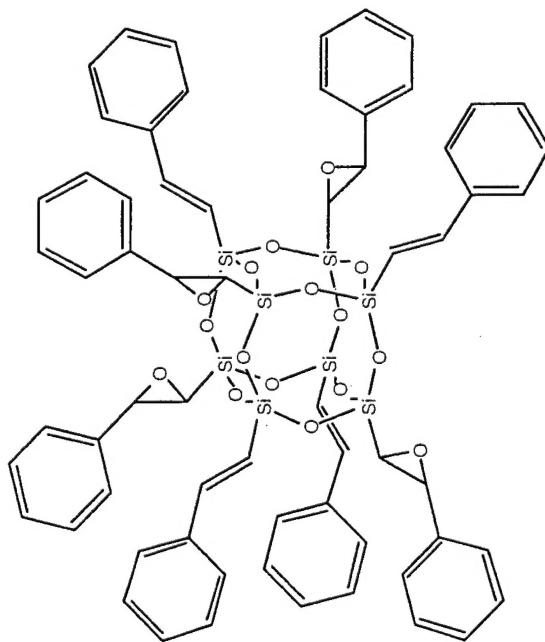
POSS Chemically Incorporated into Plastics



POSS-Kapton

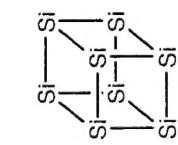
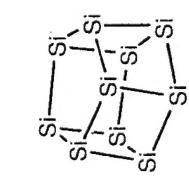
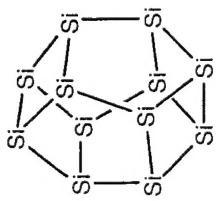
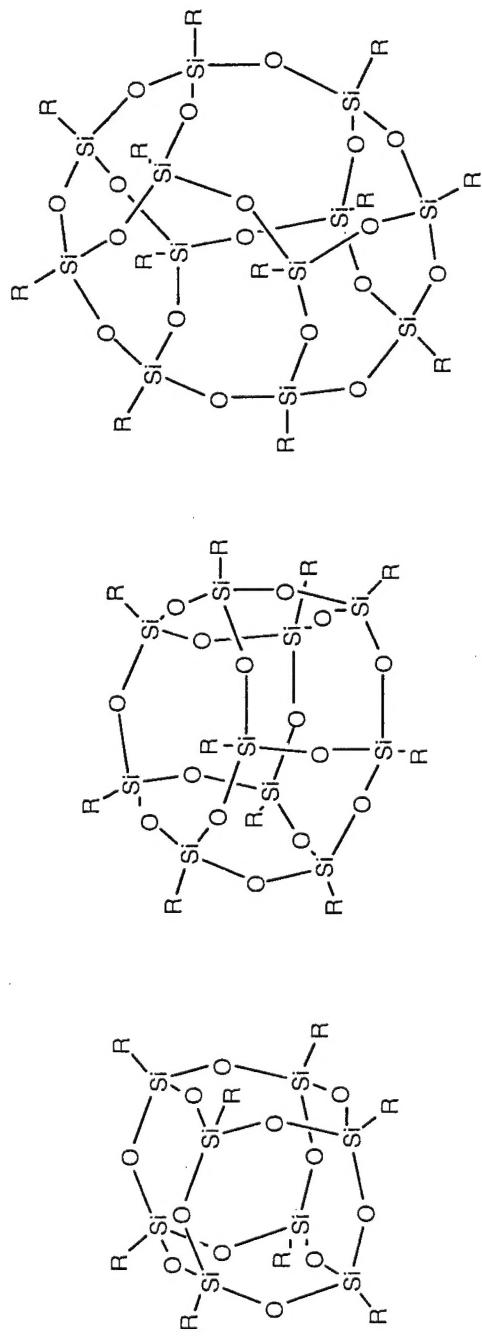


POSS-PMMA



POSS-EPOXY

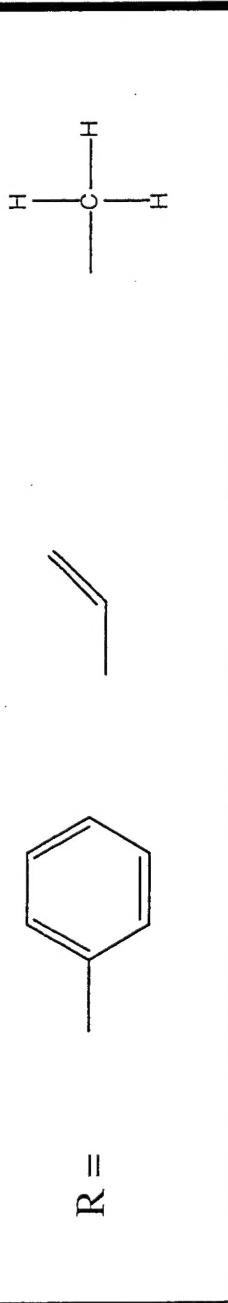
POSS Blended into Plastics



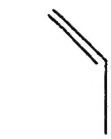
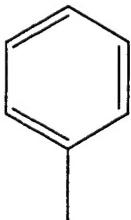
T₁₂

T₁₀

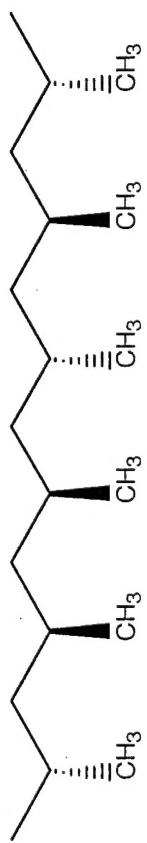
T₈



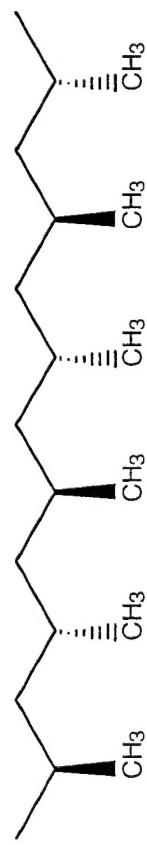
R =



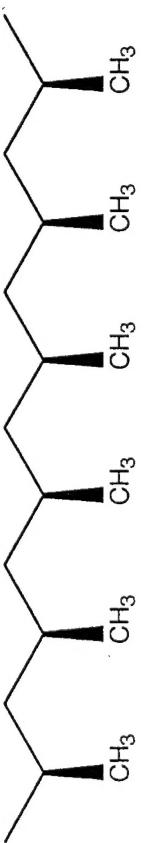
Materials Selection: Polypropylene and POSS



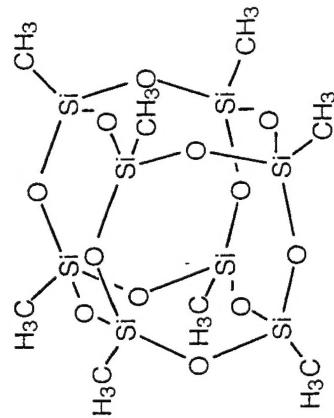
atactic polypropylene



syndiotactic polypropylene



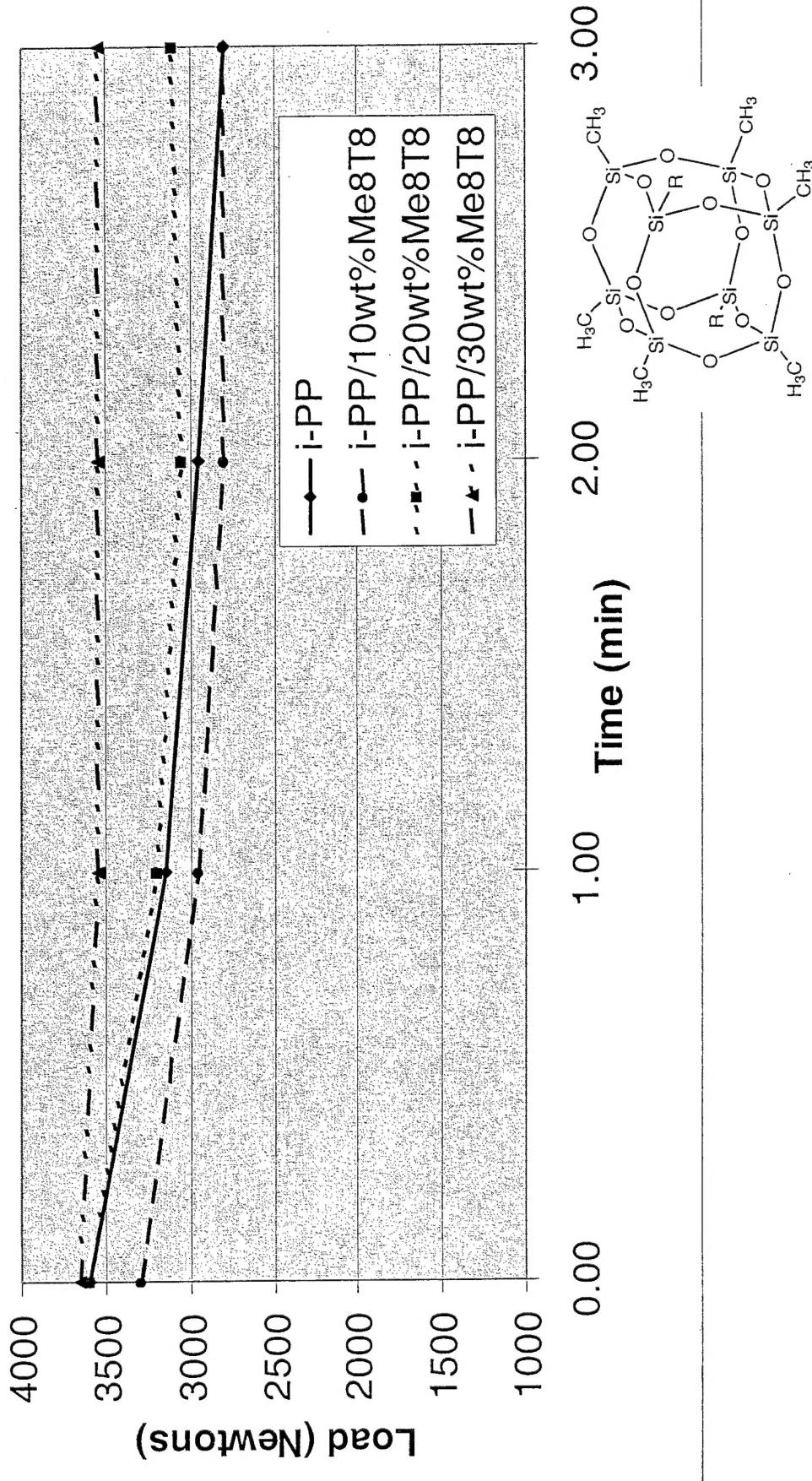
isotactic Polypropylene



Methyl₈T₈

i-PP/Me₈T₈ Processing Studies

iso-Polypropylene w/ Me8T8

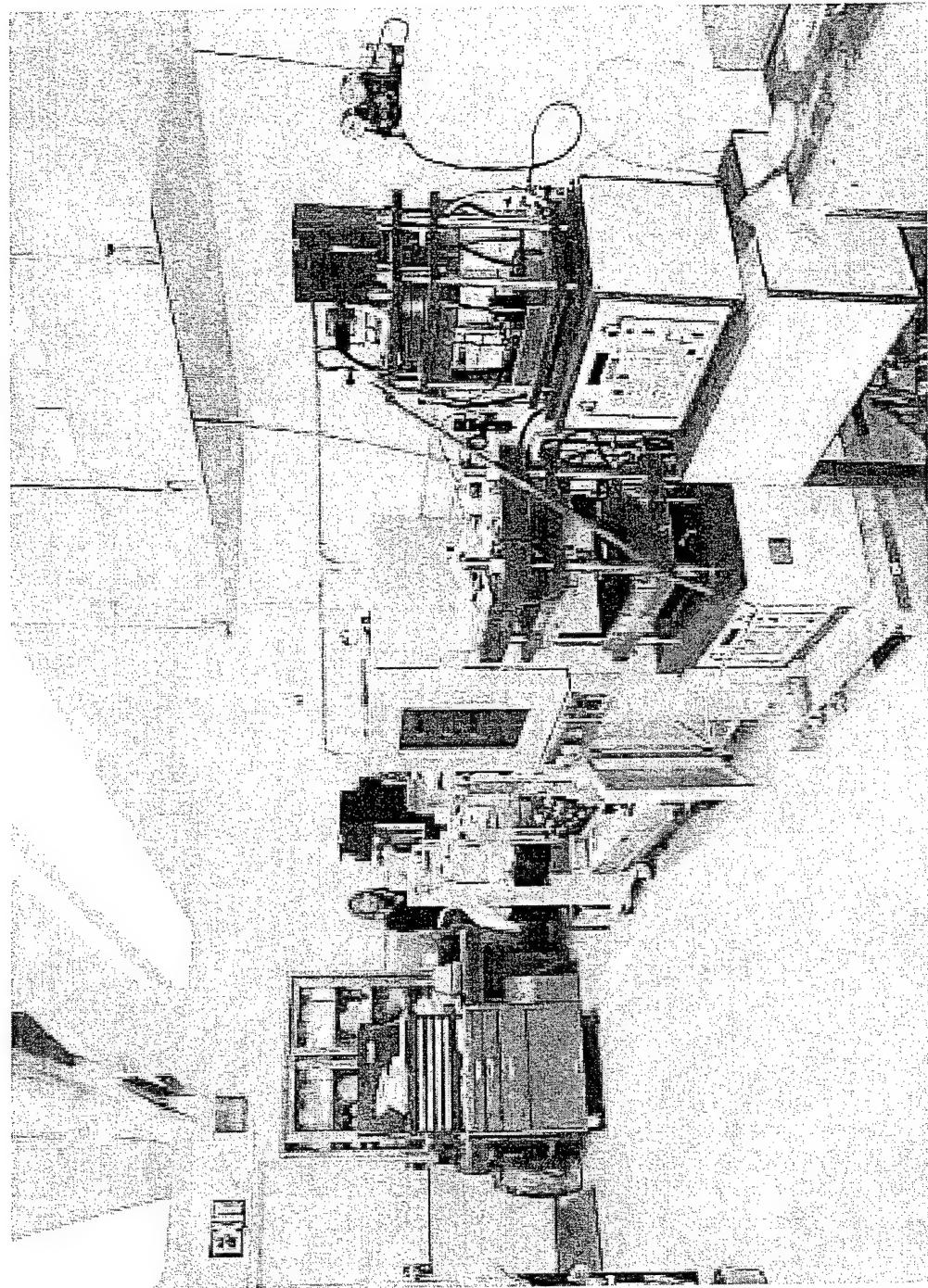


Prof. Andre Lee - Michigan State University

	Dow data	Neat <i>i</i> -PP (processed)	<i>i</i> -PP blended 2 wt% Methyl ₈ T ₈	<i>i</i> -PP blended 5 wt% Methyl ₈ T ₈	<i>i</i> -PP blended 10 wt% Methyl ₈ T ₈
Tensile Strength @ Yield; ASTM D638	5000 psi (34.5 MPa)	4800 psi (33.0 MPa)	5000 psi (34.5 MPa)	5100 psi (35.1 MPa)	5200 psi (35.8 MPa)
Flexural Modulus (0.05 in/min, 1% secant); ASTM D790A	240,000 psi (1.655 GPa)	235,000 psi (1.620 GPa)	251,000 psi (1.730 GPa)	255,000 psi (1.757 GPa)	262,000 psi (1.80 GPa)
HDT @ 66 psi, as injected; ASTM D648	210 °F (99 °C)	210 °F (99 °C)	221 °F (105 °C)	239 °F (115 °C)	255 °F (124 °C)
Impact Izod @25C ASTM D256A	0.5 ft-lb/in	0.55 ft-lb/in	0.55 ft-lb/in	0.62 ft-lb/in	0.75 ft-lb/in

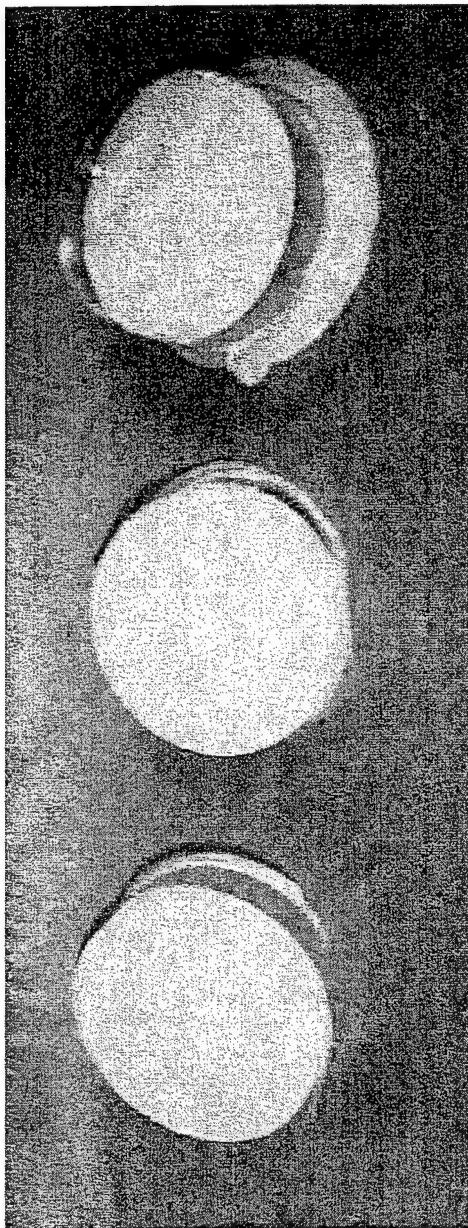
- The above data (other than Dow's data) is an average of at least 10 samples for each test with acceptable S.D. of 5% or better.

Polymer Processing Lab



Polymer Processing Parameters

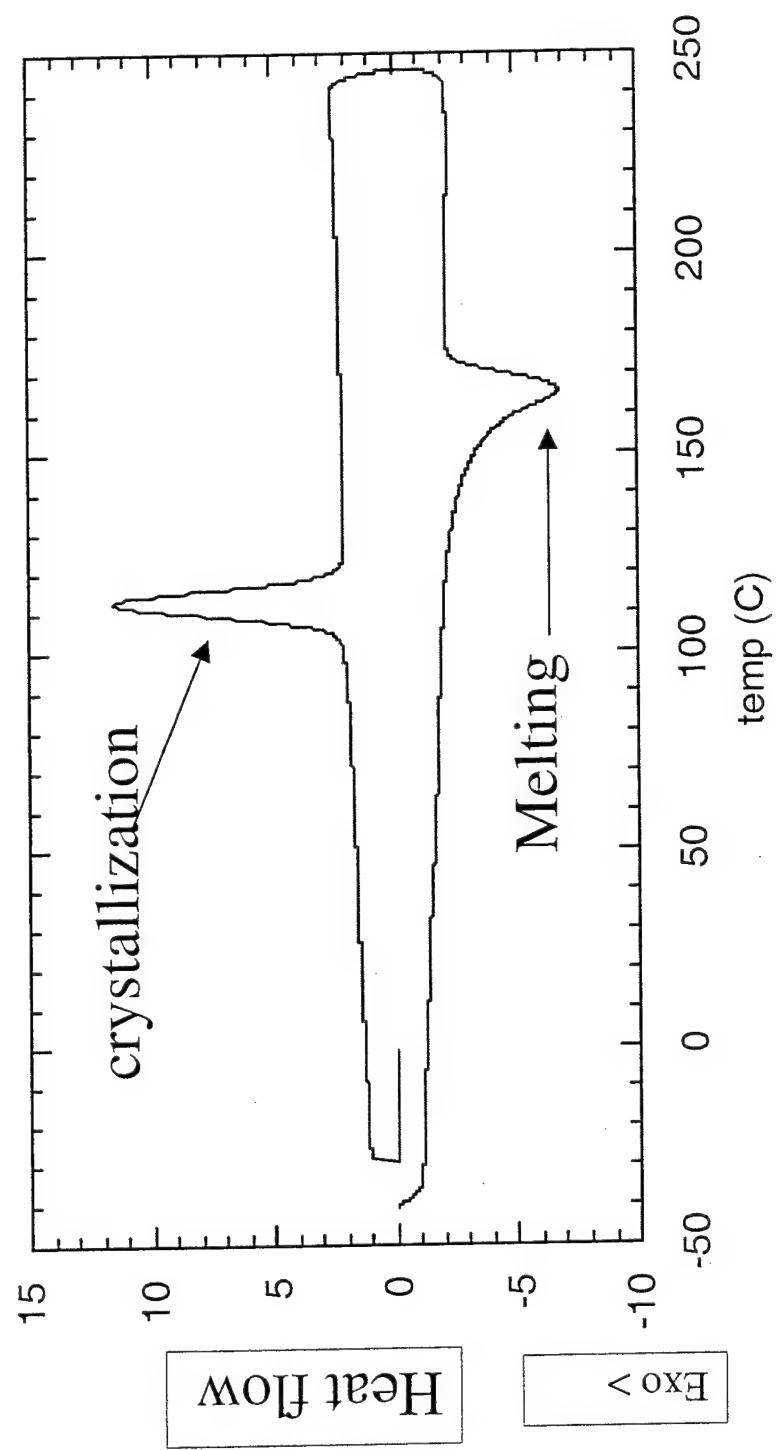
- ❖ Time
- ❖ Pressure
- ❖ Temperature



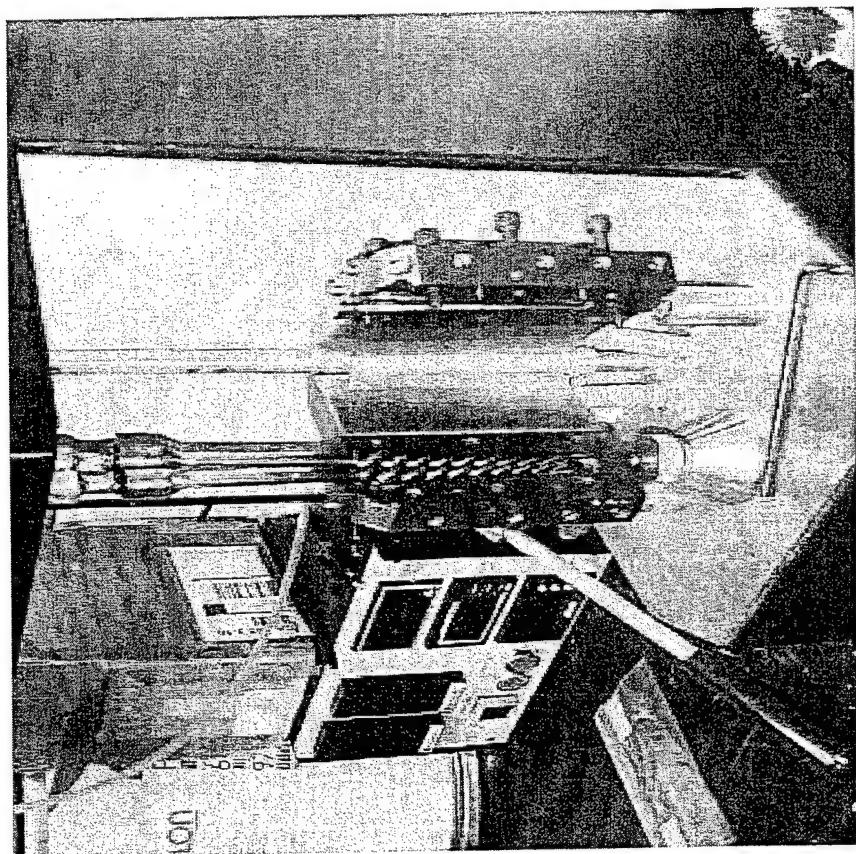
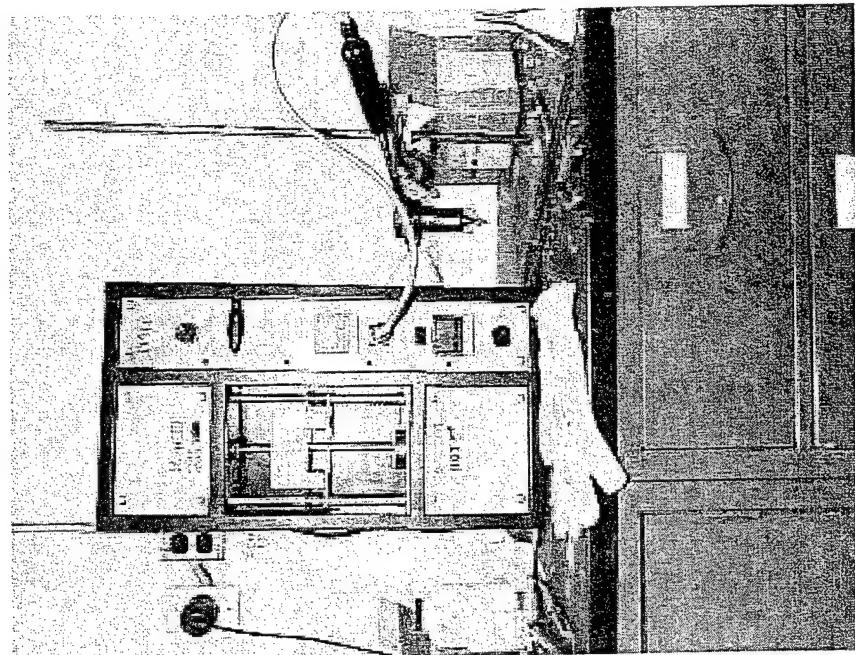
Procedure

- ❖ DSC (Establish processing and drying temperatures)
- ❖ Drying (Vacuum Oven)
- ❖ DACA (Mixing)
- ❖ Press (Forming samples)
- ❖ Tests to compare properties

Polypropylene DSC



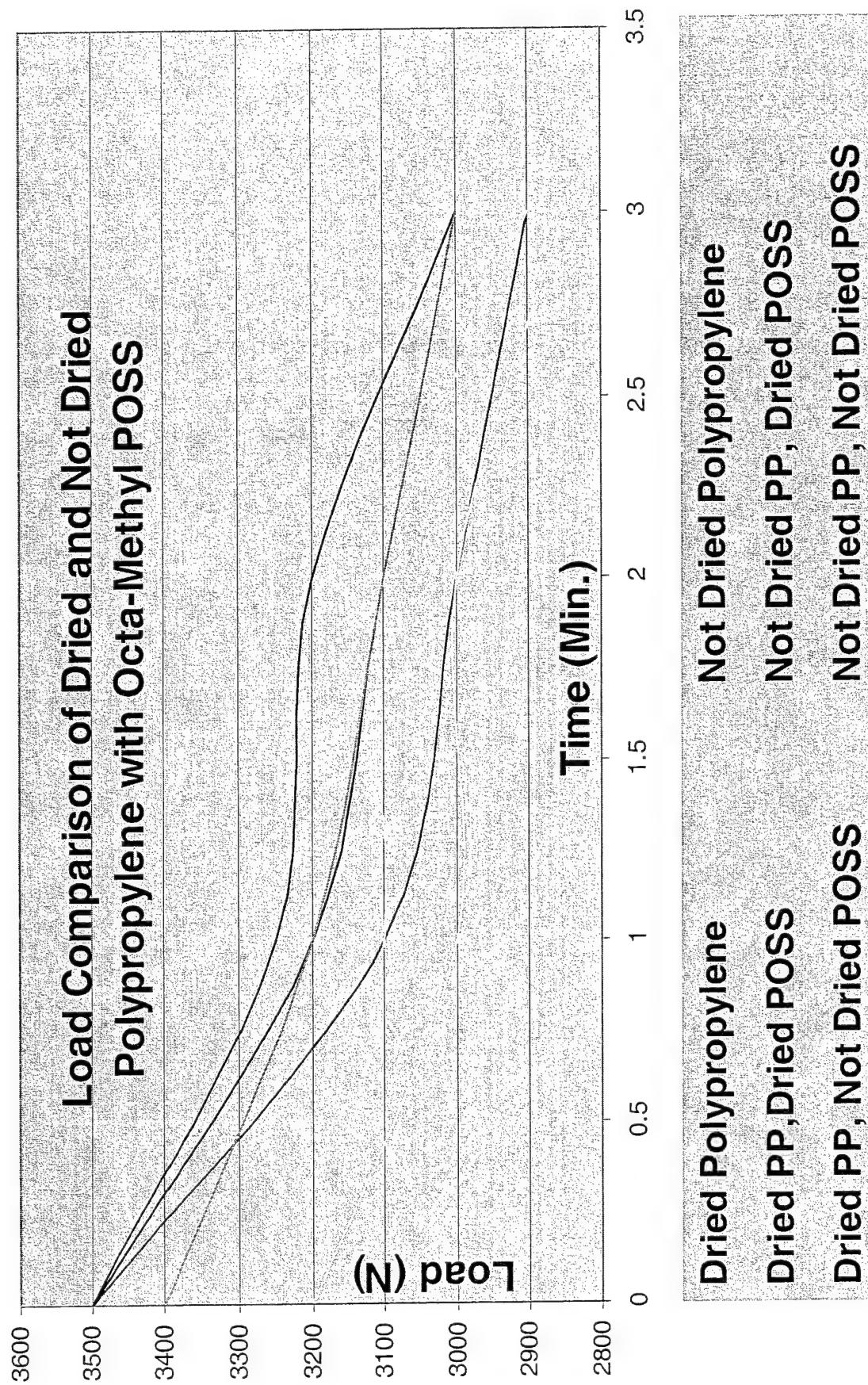
DACA

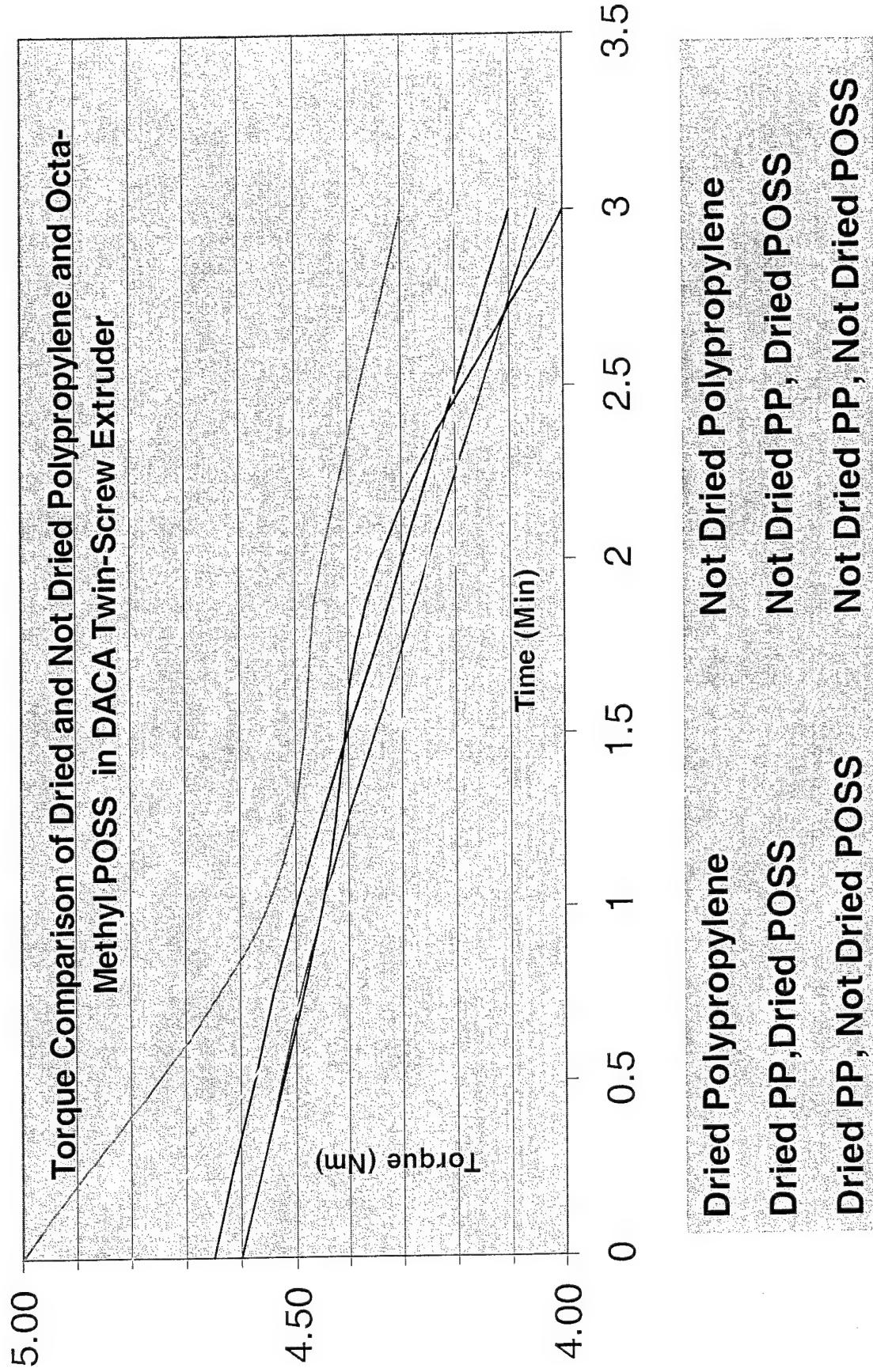


DACA Twin Screw Processing Parameters for Me8T8/iPP nanocomposite blends.

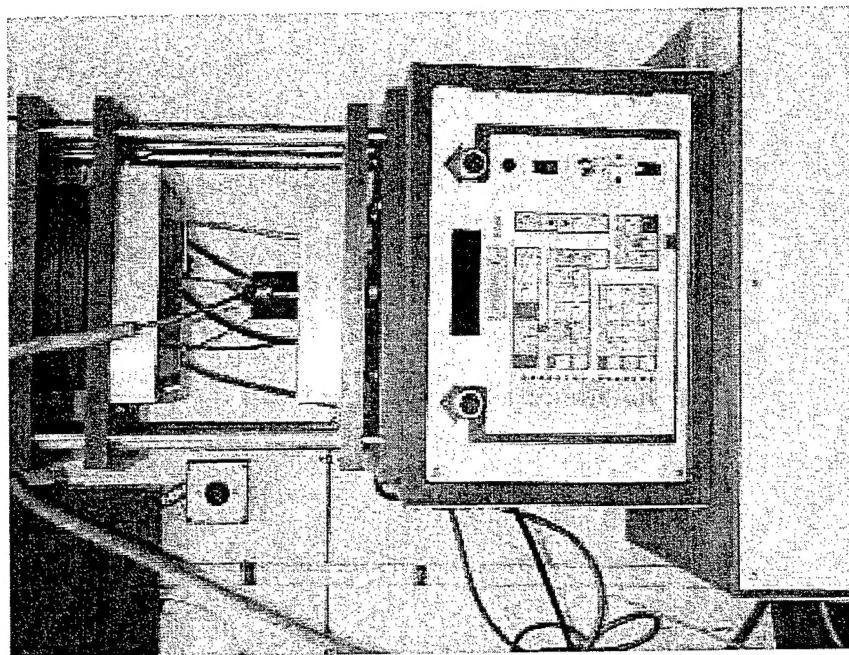
Mix #	PP	Me ₈ T ₈	Load (N)			Torque (Nm)					
			Dried	Not Dried	Dried	0	1	2	3	0	1
1	100					3500	3200	3100	3000	4.65	4.50
2	100					3500	3100	3000	2900	4.60	4.45
3	90					3200	3000	3000	2850	4.80	4.40
4	90					10	3200	3100	3100	2900	4.60
5	Hot	10					3500	3250	3200	3000	5.00
6		90				10	3400	3200	3100	3000	4.60

Press

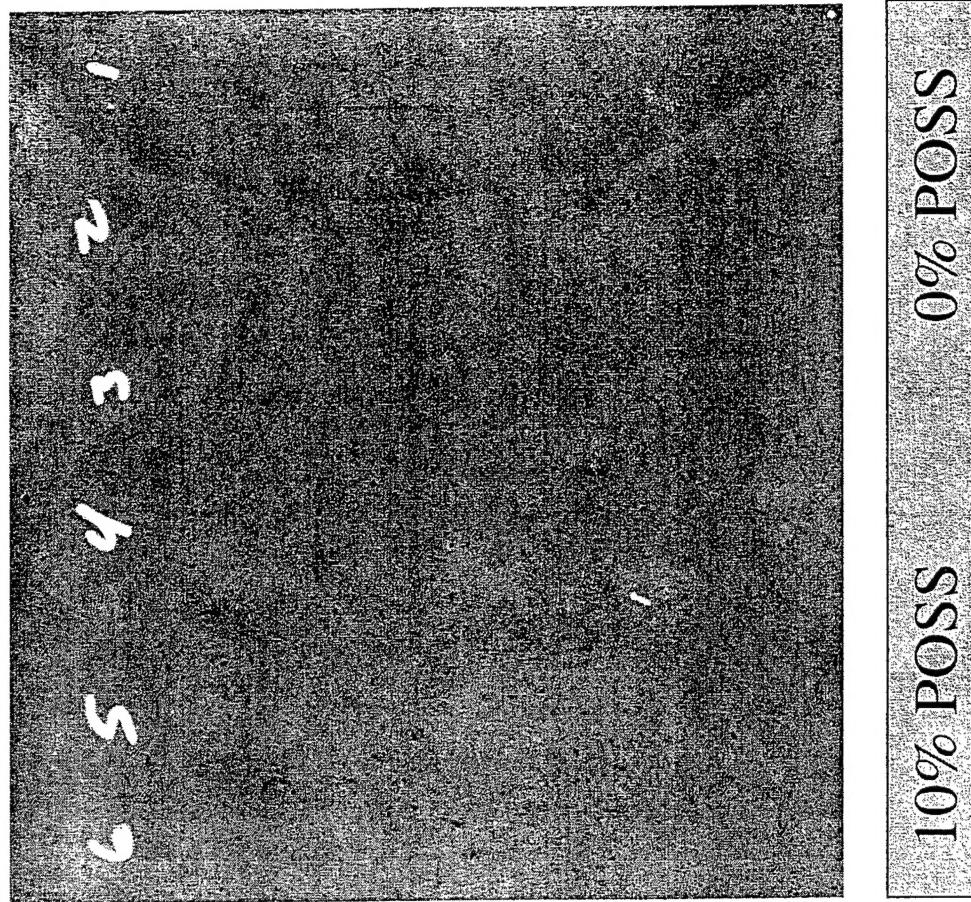




One Ton Press



Pressed film of DACA extruded POSS/PP blend variants



- 1 Dried PP
- 2 Not Dried PP
- 3 Dried PP, Dried POSS
- 4 Dried PP, Not Dried POSS
- 5 Not Dried PP, Dried POSS
- 6 Not Dried PP, Not Dried POSS

10% POSS 0% POSS

SUMMARY

Drying seems to play a roll in making Me_8T_8 compatible with isotactic polypropylene

Load/torque to mix the polymer with the POSS is increased if either of the components is not dried.

Visually, the most compatible of the mixes is number 3 where both POSS and PP components were dried. The extruded rod and pressed thin film are nearly as clear as pure polypropylene in the melt.

ACKNOWLEDGEMENTS

AFRL/PRSM: Dr. Brent Viers, Dr. Rusty Blanski, and Dr. Andre Lee
Air Force Research Lab Polymer Working Group

Hybrid Plastics: Dr. Joe Lichtenhan, Dr. Joe Schwab, and
Mr. Michael J Carr

This talk is as much about me learning my work as it is making samples.
A great deal of thanks goes to the people who do similar work and have
shown me tricks to make the technician look clever.